



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
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**Bacteria Total Maximum Daily Load Development
For Pigg River, Snow Creek,
Story Creek and Old Womans Creek
Franklin and Pittsylvania Counties, Virginia**

Signed

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Decision Rationale

Bacteria Total Maximum Daily Load Development for Pigg River, Snow Creek, Story Creek and Old Womans Creek Franklin and Pittsylvania Counties, Virginia

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a Margin Of Safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDLs for the primary contact use (bacteriological) impairments in the Pigg River Basin which includes the following impaired segments: Pigg River, Snow Creek, Story Creek and Old Womans Creek. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

- 1) The TMDLs are designed to implement applicable water quality standards.
- 2) The TMDLs include a total allowable load as well as individual waste load allocations (WLAs) and load allocations (LAs).
- 3) The TMDLs consider the impacts of background pollutant contributions.
- 4) The TMDLs consider critical environmental conditions.
- 5) The TMDLs consider seasonal environmental variations.
- 6) The TMDLs include a MOS.
- 7) There is reasonable assurance that the TMDLs can be met.
- 8) The TMDLs have been subject to public participation.

II. Background

The impaired segments included in the Pigg River Basin are located in Franklin and Pittsylvania Counties, Virginia. The total watershed area is 250,885 acres. Forested and agricultural lands make-up the majority (98 percent) of the lands within watershed. Developed lands comprise almost 2 percent of the watershed area.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed several waters in the Pigg River Basin on Virginia's Section 303(d) lists as being unable to attain their applicable criteria. Table 1 documents the impairments and year of initial listing for each listed segment. The decision to list for bacteria (fecal coliform) was based on observed violations of the Commonwealth's bacteriological criteria. At the time of their listing, the bacteria criteria used fecal coliform as an indicator species and had an

instantaneous standard 1,000 colony forming units (cfu) per 100 milliliters (ml) and geometric mean standard of 200 cfu/100 ml. This decision rationale will address the TMDLs for the impairments of the primary contact use.

Table #1 – Pigg River Basin TMDL Impairments

Segment	Stream Name	Initial Listing	Impairments
VAW-L13R-01	Old Womans Creek	1998	Fecal Coliform
VAW-L17R-01	Snow Creek	1998	Fecal Coliform
VAW-L14R-02	Story Creek	1998	Fecal Coliform
VAW-L14R-01	Pigg River	1998	Fecal Coliform
VAW-L18R-01	Pigg River	1998	Fecal Coliform
VAW-L13L-02	Leesville Lake-Pigg River	1998	Fecal Coliform

Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA encouraged the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation was drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth adopted e-coli and enterococci criteria in January 2003. According to the new criteria, streams will be evaluated via the e-coli and enterococci criteria after 12 samples have been collected using these indicator species. The fecal coliform criteria will be used in the interim. Twelve e-coli samples were collected from the waters addressed under the Pigg River Watershed TMDLs.

As Virginia designates all of its waters for primary contact, all waters are required to meet the bacteriological standard for primary contact. Virginia's standard applies for all flows, there are no high or low flow exemptions. The fecal coliform criteria was modified in 2003 to require that the fecal coliform concentration not exceed a geometric mean of 200 cfu per 100 ml of water for two or more samples collected over a month, nor shall more than 10 percent of the total samples exceed 400 cfu/100 ml of water. The new criteria also established concentration based requirements for e-coli. The e-coli criteria requires a geometric mean concentration of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml of water. Unlike the fecal coliform criteria, which allows a 10 percent violation rate, the new e-coli criteria requires the concentration of e-coli not exceed 235 cfu/100 ml of water. This caps the allowable concentration of bacteria and requires extremely stringent load reductions for attainment.

Although the TMDLs and criteria require the 235 cfu/100 ml of water for e-coli not be exceeded, waters are not placed on the Section 303(d) list if their violation rate does not exceed

10 percent. Therefore, these waters may be deemed as attaining the primary contact use prior to the implementation of all of their TMDL reductions. It is necessary to keep this in mind because of the reductions required to attain the instantaneous criteria for e-coli in the model.

Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the bacteria criteria. Bacterial source tracking (BST) sampling data collected from the impaired segments within the Pigg River Basin demonstrated that bacteria from wildlife represents a significant portion of the total bacterial load. In some instances, the loads from wildlife alone appear to violate the numeric criteria. Many of Virginia's TMDLs, including the TMDLs for the Staunton River Basin, have called for some reduction in the amount of wildlife contributions to the impacted streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below. It should be noted that in order for the impaired waters to be in compliance approximately 90 percent of the time, reductions from wildlife sources are not required. This would be the violation rate necessary for the water to be assessed as attaining criteria for 303(d) listing purposes.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In Phase 1 of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

The TMDL Report submitted by Virginia is designed to determine the acceptable load of e-coli which can be delivered to the impaired waters, as demonstrated by the use of the Hydrologic Simulation Program Fortran (HSPF)¹ in order to ensure that the water quality standard is attained and maintained. HSPF was considered an appropriate model to analyze the

¹Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

impaired water because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions. The model was run to determine the fecal coliform loading to the impaired tributaries as most of the loading information and sampling results are based on fecal coliform. The in-stream fecal coliform concentrations were then converted to e-coli using a conversion factor established by the Commonwealth.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.² Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. Wastes which are deposited directly to the stream do not need a transport mechanism. Local rainfall and temperature data were needed to develop the model. Weather data provides the precipitation data which drives the TMDL model. Weather data was collected from the Rocky Mount and Chatham weather stations.

Stream flow data was available from United States Geological Survey (USGS) gage 02058400 on the Pigg River. This allowed the modelers to calibrate and validate the hydrologic model to observed flow data within this watershed. The model was calibrated to flow data collected from the gage from September 1989 to December 1995. In the calibration process the model parameters are adjusted until a concurrence between the observed and simulated flows is achieved. To insure that the model is accurately predicting the stream's responses, the model is then compared to a different set of observed flow data while its parameters are held constant. The Pigg River TMDL model was validated to gage data collected from June 1984 through August 1989.

The TMDLs were modeled using fecal coliform loading rates as was done in previous TMDL efforts. The fecal coliform concentrations were then converted to e-coli concentrations using a translator equations developed by VADEQ. Significant reductions in the modeled load were required in order for the Pigg River and its tributaries to attain the e-coli criteria in the model. More stringent reductions were required to meet the instantaneous standard than the geometric mean. Tables 2a and 2b document the allowable loading to the Pigg River.

Table #2a - Summarizes the Specific Elements of the TMDLs.

Stream Name	TMDL (cfu/yr)	WLA (cfu/yr)	LA (cfu/yr)	MOS (cfu/yr)
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²CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

Snow Creek	8.60E+13	1.43E+11	1.39E+12	Implicit
Story Creek	1.93E+13	1.30E+10	6.50E+11	Implicit
Upper Pigg River	4.91E+13	2.06E+09	2.04E+11	Implicit
Leesville Lake-Pigg River	1.95E+14	1.65E+08	1.63E+10	Implicit
Old Womans Creek	7.24E+12	2.34E+13	5.43E+13	Implicit

Table #2b - Summarizes the Specific Elements of the TMDLs in Daily Limits.

Stream Name	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
Snow Creek	2.36E+11	3.92E+08	3.81E+09	Implicit
Story Creek	5.29E+10	3.56E+07	1.78E+09	Implicit
Upper Pigg River	1.35E+11	5.64E+06	5.59E+08	Implicit
Leesville Lake-Pigg River	5.34E+11	4.52E+05	4.47E+07	Implicit
Old Womans Creek	1.98E+10	6.41E+10	1.49E+11	Implicit

The United States Fish and Wildlife Service has been provided with a copy of the TMDL Report.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a primary contact (bacteriological) impairment TMDLs for the Snow Creek, Story Creek, Old Womans Creek, and Pigg River Watersheds. EPA is therefore approving these TMDLs. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDLs are designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality criteria and designated uses on Snow Creek, Story Creek, Old Womans Creek, and the Pigg River. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100 ml or an instantaneous standard of no more than 1,000 cfu/100 ml. Two or more samples over a 30-day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a thirty-day period, most of the samples were measured against the instantaneous standard. According to the 2004 Section 303(d) list, the violation rate for five of the six stations monitored in the watershed was between 18 and 26 percent. The last station had a 54 percent violation rate.

The Commonwealth has changed its bacteriological criteria as indicated above. The new e-coli criteria requires a geometric mean of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml of water. The HSPF model was used to determine the fecal coliform deposition

rates to the land as well as loadings to the stream from direct deposit sources. Once the existing load was determined, allocations were assigned to each source category to develop a loading pattern that would allow Snow Creek, Story Creek, Old Womans Creek, and the Pigg River to support the e-coli water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of e-coli to these waters will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Data used in the model was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, animal access to the stream, manure application rates, wildlife in the watershed, wildlife fecal production rates, landuses, weather, stream geometry, etc.. The model combined all of the data to determine the hydrology and water quality of the stream. The lands within the watersheds were categorized into specific landuses. The landuses had specific loading rates and characteristics that were defined by the modelers. Therefore, the loading rates are different in lands defined as forested versus pasture. Pasture lands support cattle and are influenced differently by stormwater runoff.

The TMDL models were run using weather data collected from local National Climatic Data Center weather stations in Rocky Mount and Chatham. The weather data was used to determine the precipitation rates in the watersheds which transports the on land pollutants to the streams through overland and groundwater flows. Waste that was deposited to the land or stored was subjected to a die-off rate. The longer fecal coliform stayed on the ground the greater the die-off was. Materials that were washed off the surface shortly after deposition were subjected to less die-off.

As stated above the model for the Pigg River TMDL was calibrated and validated to USGS gage data collected within the watershed. The gage data used for calibration and validation was collected from 1984 through 1995. The water quality models were calibrated and validated against observed data collected from each of the streams.

2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 2 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

EPA regulations require that an approvable TMDL include individual WLAs for each

point source. According to 40 CFR § 122.44(d)(1)(vii)(B), “Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR § 130.7.” Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Virginia has stated that there are three individually permitted facilities discharging bacteria within the Watersheds. There are no permitted facilities discharging bacteria to the Snow Creek or Old Womans Creek Watersheds. However, a WLA was provided in each of these watersheds to account for future growth. The WLAs for these facilities was determined by multiplying the permitted flow by the permitted bacteria concentration by 365 days. The WLAs are provided in Table 3.

Table 3 – WLAs for the TMDL

Stream	Facility	Permit Number	WLA (cfu/yr)
Story Creek	Ferrum Sewage Treatment Plant (STP)	VA0029254	6.99E+11
Pigg River	Franklin County Commer Center Waste Water Treatment Plant	VA0091103	3.48E+10
Pigg River	Rocky Mount Town (STP)	VA0085952	3.48E+12

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the impaired watersheds. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. HSPF model used precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various landuses within the watersheds. Tables 4a-e list the LAs for impaired segments within the Pigg River Basin. The reductions needed to insure that the instantaneous criteria are attained at all times are extremely stringent. For in-stream sources, the entire load is entering the stream, for land based sources it is an edge of stream load.

Table 4a - LA for Bacteria (fecal coliform) for Snow Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Cropland	2.31E+14	2.31E+14	0
Pasture	1.26E+16	6.35E+14	95
Developed	8.18E+14	4.3E+13	95
Forest	1.43E+15	1.43E+15	0
Livestock In-Stream	2.06E+14	8.20E+13	60
Straight Pipes	5.00E+12	0.00	100
Wildlife In-Stream	7.50E+13	7.50E+13	0

Table 4b - LA for Bacteria (fecal coliform) for Story Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Cropland	2.60E+13	9.00E+12	65
Pasture	2.81E+15	4.24E+14	85
Developed	5.70E+14	1.47E+14	74
Forest	2.40E+14	2.47E+14	0
Livestock In-Stream	4.00E+13	0.00	100
Straight Pipes	4.00E+12	0.00	100
Wildlife In-Stream	1.20E+13	7.00E+12	45

Table 4c - LA for Bacteria (fecal coliform) for Upper Pigg River

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Cropland	8.50E+13	6.30E+13	25
Pasture	9.10E+15	4.56E+14	95
Developed	1.30E+15	1.35E+14	90
Forest	7.03E+14	7.09E+14	0
Livestock In-Stream	9.70E+13	0.00	100
Straight Pipes	9.00E+12	0.00	100

Wildlife In-Stream	3.50E+13	3.30E+13	5
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Table 4d - LA for Bacteria (fecal coliform) for Leesville Lake-Pigg River

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Cropland	2.01E+14	2.01E+14	0
Pasture	2.95E+16	1.47E+15	95
Developed	2.50E+15	2.69E+14	90
Forest	3.07E+15	3.07E+15	0
Livestock In-Stream	2.04E+14	0.00	100
Straight Pipes	7.0E+12	0.00	100
Wildlife In-Stream	2.55E+14	1.79E+14	30

Table 4e - LA for Bacteria (fecal coliform) for Old Womans Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Cropland	7.00E+12	7.00E+12	0
Pasture	1.08E+15	1.08E+14	90
Developed	9.20E+13	1.40E+13	85
Forest	1.56E+14	1.56E+14	0
Livestock In-Stream	5.70E+12	0.00	100
Wildlife In-Stream	7.70E+12	2.5E+12	67

All of the TMDLs have been developed with a stage 1 implementation goal. The stage 1 reduction goal is for the water to violate the instantaneous criteria less than 10 percent of the time. None of the waters required wildlife controls to meet their stage 1 implementation goals.

3) The TMDLs consider the impacts of background pollution.

The TMDLs consider the impact of background pollutants by considering the bacteria load from background sources like wildlife and calibrating the model to observed conditions which naturally include background sources.

4) The TMDLs consider critical environmental conditions.

According to EPA's regulation 40 CFR § 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the impaired segments is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards³. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The HSPF models were run over a multi-year period that exhibited a wide range of climatic conditions. The allocations developed in the TMDLs will therefore insure that the criterion is attained over a wide range of environmental conditions including wet and dry weather conditions.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

Bacteria loadings also change during the year based on crop cycles, waste application rates, and cattle access patterns. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data over an extended period of time and by modifying waste application rates, crop cycles, and livestock practices.

6) The TMDLs include a margin of safety.

³EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the TMDLs through the use of conservative modeling assumptions in the determination of bacteria loadings and production. For instance all point sources were modeled as delivering their maximum permitted load.

7) There is a reasonable assurance that the TMDLs can be met.

EPA requires that there be a reasonable assurance that the TMDLs can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR § 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

8) The TMDLs have been subject to public participation.

Two public meetings were held for the Pigg River Basin TMDLs. The meetings were held on October 27, 2005 and March 09, 2006. Both meetings were held at the Sontag Elementary School in Rocky Mount and noticed in the Virginia Register for a 30-day comment period. Twenty people attended the first meeting and twelve attended the second meeting.